DESIGN AND DEPLOYMENT OF WIRELESS MULTIHOP NETWORK

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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"I hereby declare that this report entitles Design and Deployment of Wireless Multihop Network is result of my own work except as cited clearly in the references."

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Date   : 18 MAY 2012

"I hereby declare that I have read this report and in my opinion this report is sufficient in term of the scope and quality for the award of the Bachelor Degree of Electronic Engineering (Wireless Communication) With Honours."

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Date   : 1 Jun 2012

Specially dedicated to

My beloved parents, brother and sister who have encouraged, guided and inspired me
throughout my journey of education

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ABSTRACT

The purpose of this project is to Design and Deployment of Wireless Multihop Network (MWN). The basic wireless multihop network design is relay topology. However, there is alternative way of wireless multihop network which is Mesh topology. Based on 802.11 standard, the wireless multihop network consist of several access points that acts a node and link to each other and make a complete wireless local area network (WLAN). The problem that related to the Local Area Network (LAN) system encourage the usage of wireless technology since there a lot of benefits in term of cost, ease of installation and many more. The wireless technology offer more advantages over LAN, however the degradation of network performance arise within the network because of channel interference with other available access points. By testing with different frequencies for each of the access points before conduct any deployment activities in an area, the channel interference can be avoided and make a better performance of wireless networking . Test bed is developed to evaluate the performance of wireless multihop networks in real environment. By using suitable tool that related to wireless analysis performance, the real capabilities of the network can be measured. The project begins with designing the network, then deploys the access points at cafe of UTeM industrial campus and then makes an analysis of it. Further process will be discussing more in chapter III of this report. An analysis like ping test, data rate, jitter and datagram loss of the networks and also performance of the network with different frequencies were also considered in order to confirm the functionality and performance of the wireless multihop network.

ABSTRAK

Tujuan projek ini adalah untuk Mereka dan Memasang Rangkaian Wayarles Berangkai. Topologi rangkaian yang digunakan ialah topology berangkai. Bagaimanapun, terdapat alternatif selain dari topologi berangkai iaitu topologi Mesh. Berdasarkan 802.11 standard, rangkaian wayarles berangkai ini terdiri daripada beberapa pusat akses yang bertindak sebagai nod dan menghubungkan satu sama lain untuk menjadikan ia sebagai rangkaian tempatan wayarles (WLAN) . Masalah yang berkaitan dengan rangkaian tempatan tanpa wayarles (LAN) menggalakkan lagi penggunaan teknologi wayarless kerana mempunyai kelebihan dari segi kos, konfigurasi yang mudah dan banyak lagi. Teknologi wayarles menawarkan lebih bygk kelebihan dari LAN, tetapi penurunan prestasi rangkaian meningkat di dalam rangakaian disebabkan pertindihan frekuensi dengan pusat akses yang lain. Ujian frekuensi berlainan yg digunakan di setiap access points sebelum melakukan pemasangan telah dilakukan untuk mengelakkan gangguan frekuensi dan menjadikan rangkaian wayarles lebih baik. Ujian telah dilakukan untuk menganalisa prestasi wayarles supaya keupayaan rangkaian dapat di tentukan. Projek ini dimulakan dengan mereka rangkaian kemudian memasang pusat akses di kafe UTeM kampus industri dan kemudiannya menganalisa. Maklumat proses lanjutan akan diterang sepenuh di bab III laporan ini. Analisis seperti ujian ping, kadar penghataran data, ketar dan paket hilang di dalam rangkaian dan juga prestasi rangkaian dengan frekuensi yang berlainan juga dipertimbangkan untuk memastikan bahawa rangkaian tersebut berfungsi and prestasi rangkaian dapat dikenalpasti.

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LIST OF ABBREVIATION

WLAN   -   Wireless Local Area Network

LAN   -   Local Area Network

WMN   -   Wireless Mesh Network

MWN   -   Wireless Multihop Network

IEEE   -   Institute of Electrical and Electronics Engineers

AP   -   Access point

APs   -   Access points

OSI   -   Open System Interconnection

ESSID   -   Extended Service Set Identification

RSSI   -   Received Signal Strength Indication

Ch   -   Channel

CHAPTER 1

INTRODUCTION

1.1   Introduction to Wireless Local Area Network

Over the past few years, the world has become increasingly mobile. As a result, traditional ways of networking the world is not enough to meet the challenges nowadays. If users need to connect to a network by using traditional ways by using physical cables, their movement is dramatically reduced. Wireless connectivity poses no such restriction and allow a great deal for more free movement. Thus, wireless technology goes beyond traditional network in term of fixed or wired networks [1]. Wireless local area network (WLAN) can be described as wireless communication that occurs only on the last link between base station and wireless end system. In multihop wireless networks, there are one or more intermediate nodes along the path that receive and forward packets via wireless links. There are several benefits of multihop wireless networks (MWN) compared to networks with single wireless links [2]. The most important benefits are MWN can extend the coverage of a network and improve connectivity. Moreover, transmission over multiple short links might require less transmission power and energy than that required over long links. This will bring result for higher data rates and at the same time higher throughput and more efficient use of the wireless medium. Other than that, in term of cost, MWN networks avoid wide

deployment of cables and can be deployed in a cost efficient way. Besides that, there will always several path available to increasing the robustness of the network. Currently, there are two types of network topology that can be implemented in a multihop wireless network. The type of topology introduced may have different characteristics in term of architecture, performance and several technical issues. The two types of network topology are multihop relay network and mesh network.

Multihop relay network can be described as chain connection that start from source of the router that connect to network backbone then make a wireless multihop connection to another access point and then the first connected access point connected to other access point and so on. Usually, relay concept applied to cellular network and wireless access. The obstacles problems can be overcome by applying relay network and it also help improve the capacity by decreasing the distance. However, there will increasing delays if there are too much numbers of hops between access points. Other problems that can be relate is when one of the access points malfunction, all the entire network will suffering major breakdown which means there are no connection to internet gateway but client still can connect to available access points. Multihop relay network can be illustrated as Figure 1.1.
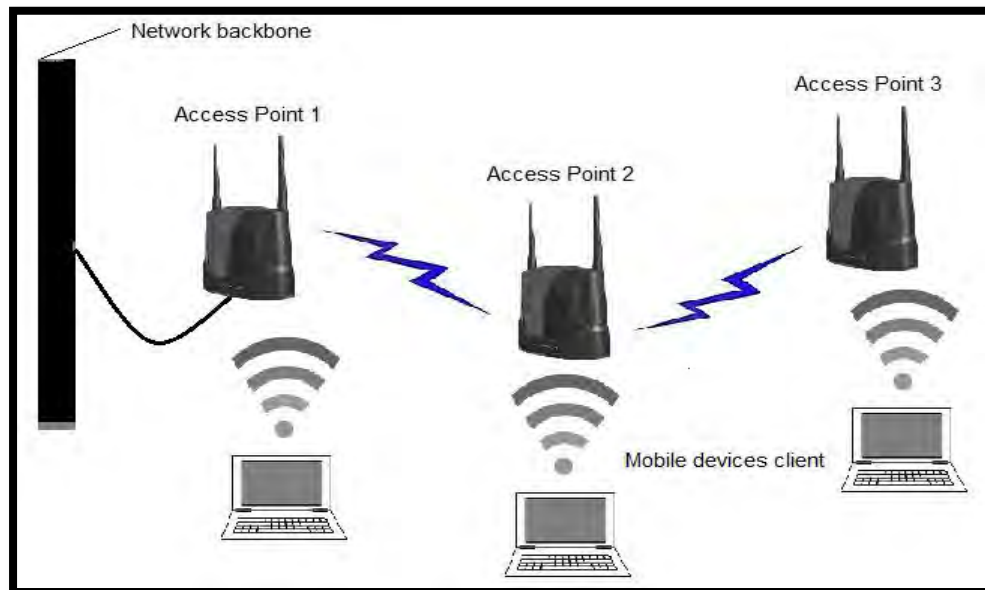
Figure 1.1: Wireless Relay Network Topology

The other network topology is multihop mesh network. Wireless Mesh Network (WMN) are composed of wireless access point that facilitates the connectivity and intercommunication of wireless clients through multi hop wireless paths. WMN can connect to the internet via gateway routers. The access points were considered as the nodes of mesh network and its may connected in a hierarchical fashion. WMN was totally different from Mesh Ad-Hoc Network or known as MANET. Unlike MANET, end host and routing node are different. The access points are usually fixed. The advantage of WMN can be described as low up-front cost, easy network maintenance, robustness, reliable service coverage and so on. Currently WMN undergoing rapid commercialize that can be implemented as applications in community networks, enterprise networks, home networks, LAN for Hotels, Malls, Trains and high speed broadband in Metropolitan area network. In this project, mesh topology only referring as case of analysis since there are lots of research about it, only MWN topology will be implemented. The illustration of WMN can be seen from Figure 1.2.
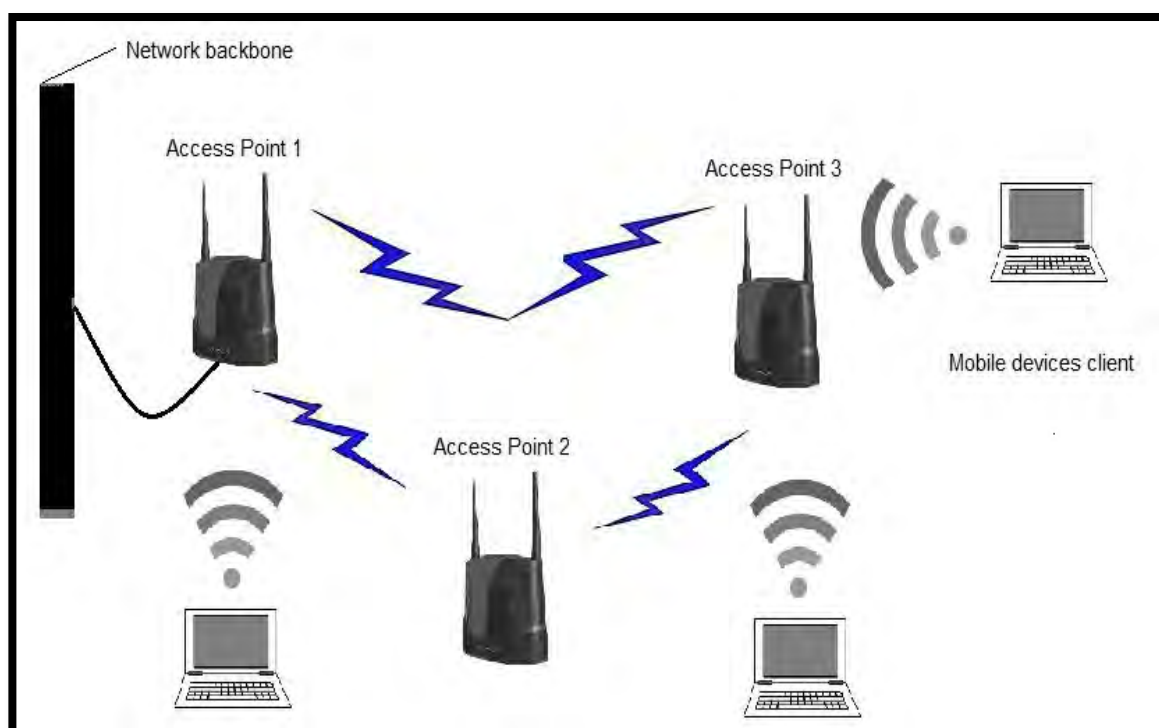
Figure 1.2: Wireless Mesh Network Topology

1.2   Objectives

    i.   To design basic outdoor wireless multihop network based on 802.11 (relay topology).

   ii.   To analyze the performance of multi hop network in term of number of clients or hop, channels interference and data rate or throughput.

  iii.   Investigates and study effect of different frequencies in MWN

1.3   Problems statement

Local area network (LAN) in general was used to connect local area in small building, office environment, indoor area in house and others certain area that require connection. The combination of wireless technology with LAN will ease the job making local area connection. This combination was known as WLAN. As we all already know, LAN requires lots of cables to make connection between computer to switches or hub and so on. However, WLAN require less cable than LAN and have lots of advantages over LAN. The problems that occurs in local area network can be listed as below :

    i.   If sever develops a fault then user may not be able to run the application programs.

   ii.   A user can lose their data if there a fault in the network.

  iii.   When there suddenly the network stop operating, it may not access to various of computer.

   iv.   Hacker may penetrate into the system and security leakage might occur.

    v.   The network will be less efficient in long term.

   vi.   If there are lots of users connect to the network, it may degrade the network performance.

  vii.   It is difficult to manage larger network since it is hard to do maintenance and require lots of cost.

The problems statement also can be relate to available wireless network, since this project focus on implementation on wireless multihop network at outside area. The cafeteria of UTeM industrial campus has been chosen to implement this wireless multihop network since there are several problems that can be recognized such as the available router was not provide large coverage to the user including users outside cafeteria. Other than that, when there are too many client connect to one router, the performance of the network can degrade. Other problems that can be recognized is the current installed access point is fix channel, so the interference of channel with other router or access point can reduce the network performance. That why, there will be implementation of dynamic channel to the wireless multihop network.

1.4   Scope of Project

The scope of this project is divided into two part. The first part is about literature review about the access points provided by MIMOS model WiWi. This access point is a hybrid WiMAX and Wi-Fi radio system platform intended to provide users with reliable high speed data, video and voice services for improved performance of wireless data applications, enhanced multimedia content delivery, VoIP application and improved user quality of service. 802.11 b/g standard was utilized in the platform of WiWi access point. The radio supports 2.3 GHz range for WiMAX as regulated by Malaysian regulator together with 2.4 GHz Wi-Fi access.

The designing of wireless multi hop network need to consider first depending on location for installation of access points. The location of each access points is depends on ease of installation and nearest power supply to provide power to access point so that it can operate all time and clients can connect to it all time. After all information gathered, the deployment of wireless multi hop network can begin.

After deploy all the access points, the configuration of output power and channel can be done by using open source software such as Terminal in Linux operating system.

The open source software also can be use to establish the connection and make multihop between deployed access points. This can be done by using Terminal provided by Linux operating system.
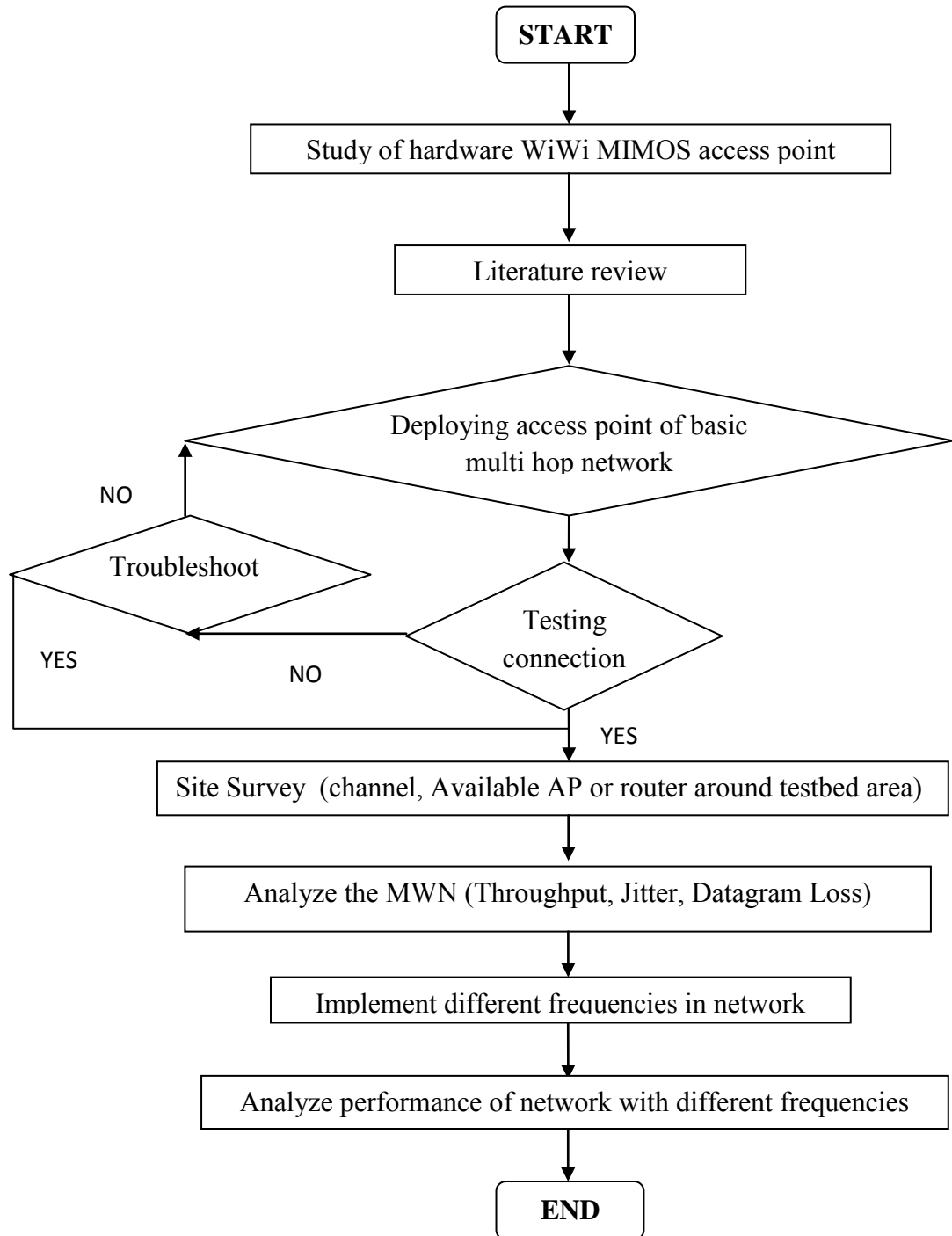
The deployment of access points according to design of relay network. This is basic wireless multihop network. The deployed of 3 access points with one of its connect to network backbone so that the internet can applied to the network. Then, the connectivity is tested by make ping test from router to router and from client to client.

After all tested has been done and satisfied, the performance of wireless multihop network then will be analyzed by using software such as inSSider, Ekahau, Air magnet and IPerf. The channel of each access points that are available around the area is analyze by using inSSider software. Meanwhile, by using Ekahau and Air Magnet software, the new deployed access point coverage can be observed. As an additional analysis about the wireless multihop network, the IPerf source code is used to measure the data rate and bandwidth of the network. All the analysis is important as it will be the initial step of improvement the performance of the network.

1.5   Summary of Methodology

First of all, the hardware provided that is WiWi MiMOS access point need to be study and research first by reading the technical manual provided. From this manual, the overall information about the hardware can be learn more and troubleshooting the access point if there is problem while handling it. After done researching and studying the hardware, the next step is literature review that related to this project. The literature review includes the study of MWN test bed and channel allocation in wireless multihop network. Based on literature review, the suitable software that need to use while designing the wireless multihop network can obtained. The literature review also give knowledge about the whole operation of wireless networking and how to analyze also test the network. After that, there will be deploying of access points and analyzing the

performance of the network and implementing dynamic channel. Below is the flowchart for overall process of this design and deployment of wireless multihop network :

```
                            ┌──────────┐
                            │  START   │
                            └──────────┘
                                 │
                                 ▼
              ┌──────────────────────────────────────────┐
              │  Study of hardware WiWi MIMOS access point │
              └──────────────────────────────────────────┘
                                 │
                                 ▼
                      ┌──────────────────────┐
                      │  Literature review    │
                      └──────────────────────┘
                                 │
                                 ▼
                   ◇ Deploying access point of basic
                        multi hop network ◇
                                 │
                                 ▼
                        ◇ Testing connection ◇
                                 │ YES
                                 ▼
```

NO

Troubleshoot

YES   NO

Site Survey (channel, Available AP or router around testbed area)

Analyze the MWN (Throughput, Jitter, Datagram Loss)

Implement different frequencies in network

Analyze performance of network with different frequencies

END

1.6   Report Outline

In this report, there are 5 chapters. Each of the chapter represents various information regarding on this project. Below is the outline of Design and Deployment of Wireless Multihop Network :

Chapter I : This chapter discuss about the overview of project such as background of the project, objective, scope of the project, problem statement and methodology.

Chapter II : This chapter discuss about all the information from the project. Its more concentrate about literature review of hardware, software, operation and method of analysis.

Chapter III : This chapter discuss about the methodology of the project. The deployment and test bed of access point with explanation of it.

Chapter IV : This chapter discuss about the result for overall of the project. The result based on software used while conducting test to the network. It also includes analysis of the network.

Chapter V : This chapter include conclusion and suggestion for the project.